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Algorithm for Handover in Zigbee Environment

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ABSTRACT

In recent times, there has been significant increase in the deployment of Wireless Sensor Networks (WSNs) in different environments. ZigBee is commonly employed in various industrial applications and for home automation. ZigBee technology is based on the IEEE standard 802.15.4. The advantage of ZigBee is that it provides short range communication with low power and less cost. In this paper, we have implemented and analyzed typical handover scenarios in ZigBee environment.

Keywords: *Wireless Sensor Networks (WSNs), Received Signal Strength (RSS), ZigBee*

1. INTRODUCTION

For localized communications, there has been considerable demand for low power transceivers. This has been met through the development of Wireless PAN (Personal Area Network) and Wireless LAN (Local Area Network) technologies. WLAN is based on IEEE 802.11/a/b standard. Bluetooth is a widely used WPAN which functions on the basis of the IEEE standard 802.15.1. [1] [2] [3] ZigBee is being explored as an alternative to Bluetooth for systems requiring low power consumption.

Figure 1 shows the use of ZigBee technology in various fields [1] [2] [3] [4] [5].

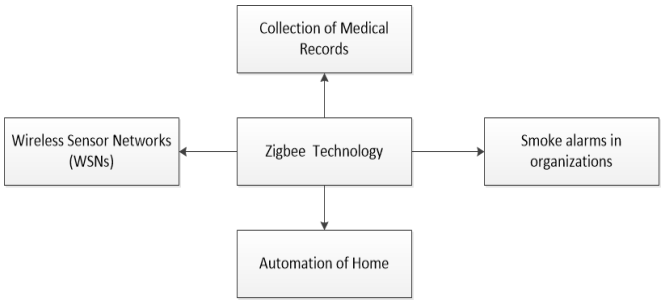

Figure 1 Use of ZigBee technology

The paper is organized as follows: Section 2 captures the mathematical background. Section 3 explains the system design. Simulation results are given in Section 4. Conclusion and future scope are presented in Section 5.

2. MATHEMATICAL BACKGROUND

A. Zigbee Topologies

There are three topologies used in deployment of ZigBee technology. They are captured as under: -

i. Star topology
ii. Cluster tree topology
iii. Mesh topology [2] [5] [6] [4]

Figure 2, 3 and 4 show the star, cluster tree and mesh topology respectively.

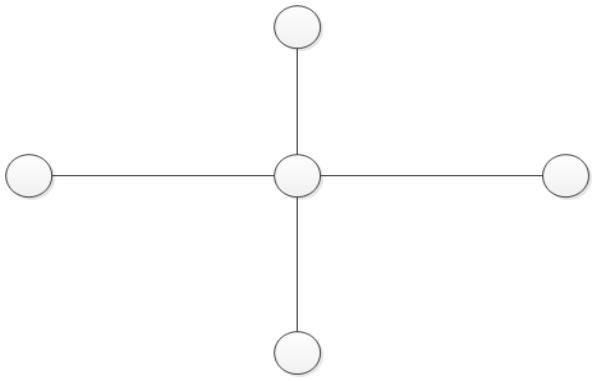

Figure 2 Star Topology

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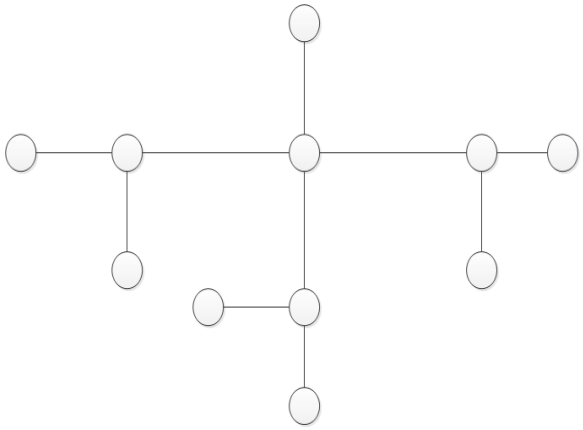

Figure 3 Cluster tree topology

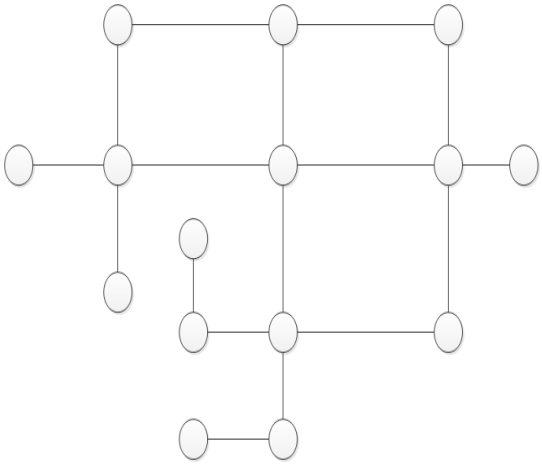

Figure 4 Mesh Topology

Table I shows the comparison of ZigBee & Bluetooth. As shown in the data rate of ZigBee is lower than the Bluetooth. However the coverage distance of ZigBee is higher than Bluetooth. [1] [2] [3] [6] [5] .

Table I Comparison between ZigBee & Bluetooth

S. No	Parameter	Unit	ZigBee	Bluetooth
1	Data-rate	Kbps	20 – 250	1000 - 3000
2	Coverage distance	Meters	10 - 100	2- 10
3	Applications	-	Wireless sensor networks	Data logging applications to connect devices to computer

Figure 5 shows the states of operation of ZigBee nodes [3] [2] [6] [5].

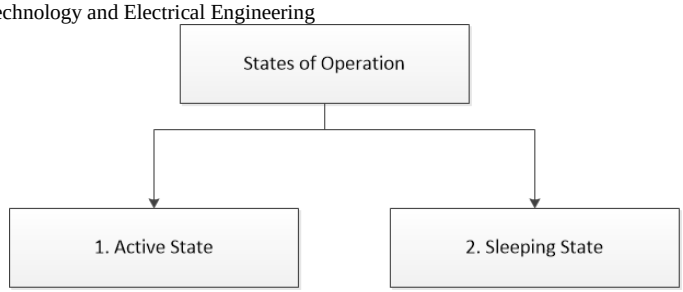

Figure 5 States of Operation

B. Handover – Definition & Phases

Handover/Handoff can be described as the process of switching connections when a mobile terminal moves from the wireless coverage area of one access point/node to the coverage area of another access point/node. [7] [8] [9] [10]

When both the access nodes are of same radio access technology (RAT) then it is known as horizontal handover.
When both the access nodes are of different RAT then it is known as vertical handover. Figure 6 describes types of handover [11] [12] [13] [10]

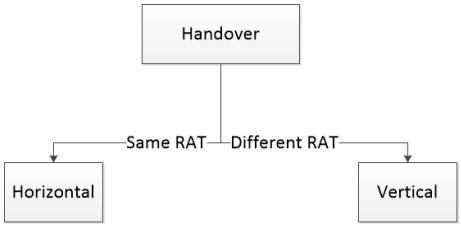

Figure 6 Types of Handover

Figure 7 shows the presence of the heterogeneous networks consisting of 3G, 4G &Wireless Local Area Network (WLAN) [8] [14] [15].

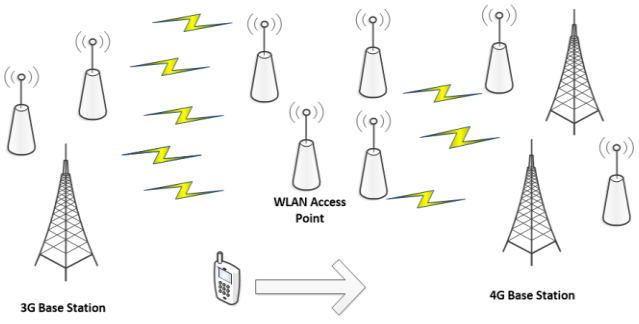

Figure 7 Presence of heterogeneous networks

Handover involves three phases. Three phases are captured as under:

i. System discovery
ii. Decision for handover
iii. Execution of handover [16] [17] [18]

Figure 8 describes the phases of handover.

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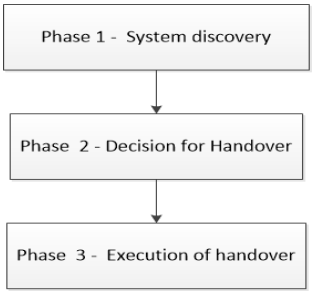

Figure 8 Phases of Handover

C. Received Signal Strength (RSS)

Handover decision is made based on the relative values of critical parameters of the two or more available networks/access points. RSS is the most prominent parameter that initiates handover [15] [19] [20].

RSS at a distance d from the transmitter node is given by following equation

$$RSS = P_0 - 10\eta \log\left(\frac{d}{d_0}\right) \quad (1)$$

Where

RSS – Received Signal Strength
η – Path Loss exponent
d – distance from transmitter (in mtrs)
d0 – fixed distance from transmitter for reference (in mtrs)
P0 – Received power at the reference distance d0 [15] [19] [5]

3. SYSTEM MODEL DESIGN AND IMPLEMENTATION

Figure 9 represents flowchart for handover. Figure 10 represents the decision algorithm for handover.

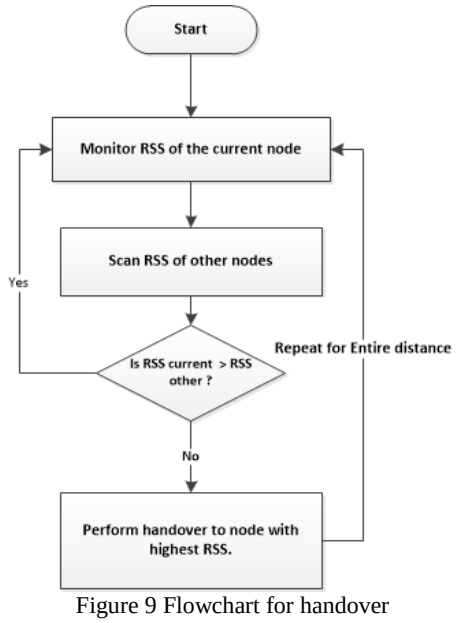

Figure 9 Flowchart for handover

As shown in figure 9, RSS of the current node is measured continuously. Simultaneously, RSS of other nodes in the vicinity is monitored. The condition to be checked is whether RSS of the current node remains greater than the RSS of other nodes. As long as RSS of the current node is greater than that of other nodes, no handover is initiated. When RSS of any other node becomes greater than that of the current node, handover is performed to that node. The algorithm proposes continuous monitoring of RSS.

Algorithm ; Decision for Handover

Input(s) :
Received Signal Strength (RSS) of all Nodes

Output :
Handover to the network

Steps to be followed :

1. Monitor the RSS of the current node.
2. Scan the RSS of other nodes.
3. Check for RSS of current node > RSS of other nodes ?
   If Yes, Go to Step 5.
   else
   Keep monitoring the RSS of current node.
4. Perform handover to the node with highest RSS.

Figure 10 Algorithm for handover

Figure 11 shows the handover execution process.

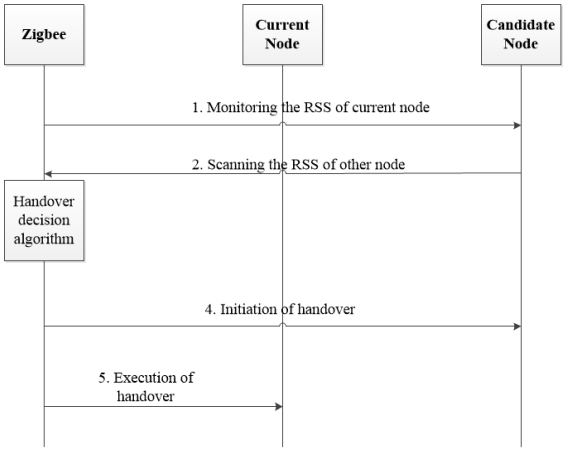

Figure 11 Handover Execution Process

4. SIMULATION & RESULTS

The Simulation has been done in Scilab.

A. Simulation Scenarios

Figure 12 shows the simulation scenario.

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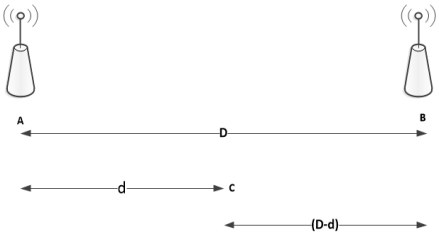

Figure 12 Simulation Scenario

As shown in Figure 12, there are two nodes at point A & B. The distance between two nodes A & B is D mtrs.

For any point C, which is at a distance d from point A,

AB = D mtrs

AC = d mtrs

CB = (D-d) mtrs

Table II shows the simulation parameters and values.

Table II Simulation values

Parameter	Value
Distance between two nodes (D)	100 mtrs
P_0	25 dBm
η	Varies from 1 to 1.5

Path loss exponent, η is a parameter indicating the rate at which the received signal strength (RSS) decreases with distance, and its value depends on the specific propagation environment. We have considered various scenarios, with Path loss exponent η varying between 1and 1.5.

B. Results

Simulation results have been shown in the following figures. In all the figures, X axis represents distance between the two nodes and Y axis represents the RSS (Received Signal Strength). The distance is measured in meters and Received Signal Strength (RSS) is measured in dBm.

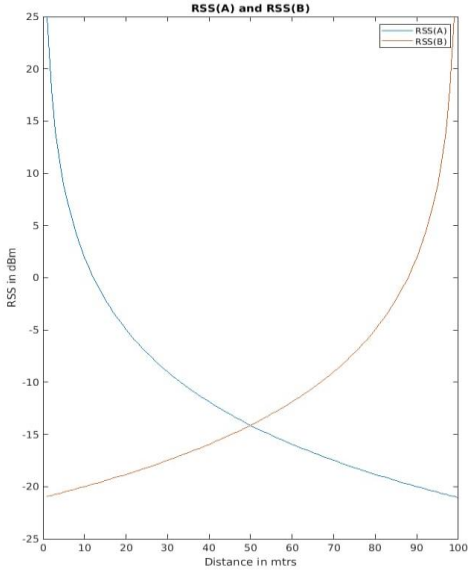

Figure 13 Variation in RSS for Node A & B for η = 1

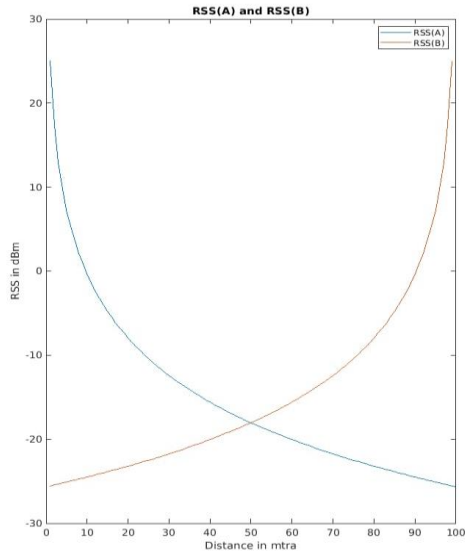

Figure 14 Variation in RSS for Node A & B for η = 1.1

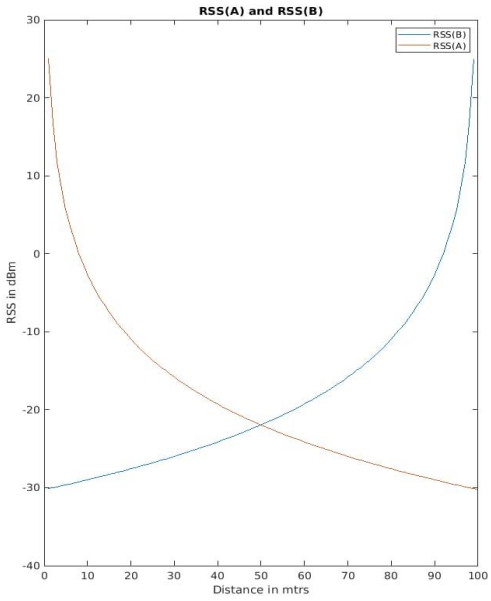

Figure 15 Variation in RSS for Node A & B for η = 1.2

Observation from above figures: We observe that as the user moves from Node A to B i.e. as distance from Node A increases, the RSS of Node A decreases while RSS of Node B increases. The handover happens midway at 50 mts between the nodes A and B. This happens as both the nodes have the same transmit power.

The point of handover is the point where the RSS of Node A goes below the RSS of Node B. The handover point remains the same, with η varying between 1and 1.5.

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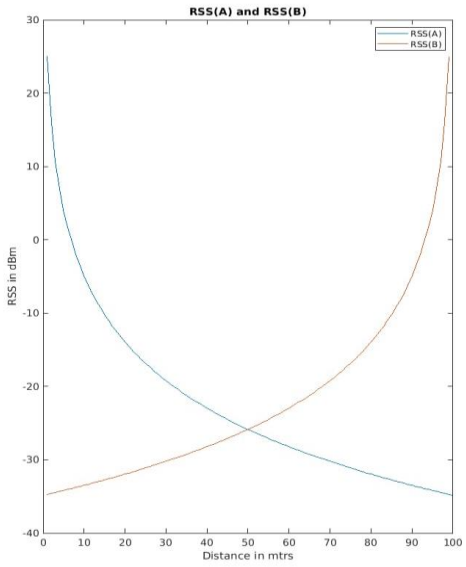

Figure 16 Variation in RSS for Node A & B for η = 1.3

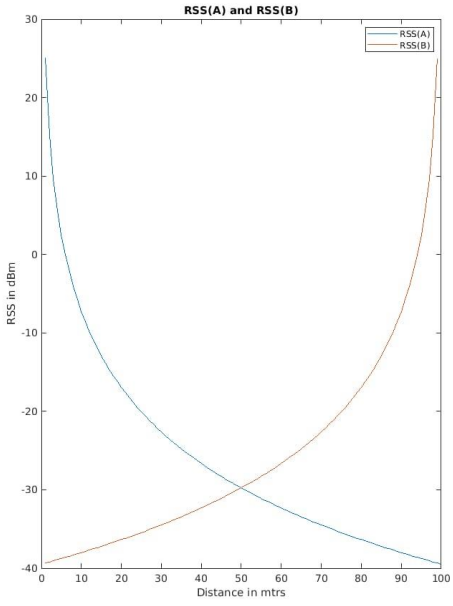

Figure 17 Variation in RSS for Node A & B for η = 1.4

5. CONCLUSION & FUTURE SCOPE

This paper captures the implementation of the algorithm for handover decision in a ZigBee environment for different path loss exponent values. The decision for handover is based on Received Signal Strength (RSS).

In a typical indoor environment, the handover point is immune to slight variations in the Path loss exponent.

Future work includes identification and inclusion of other critical parameters in the handover decision process.

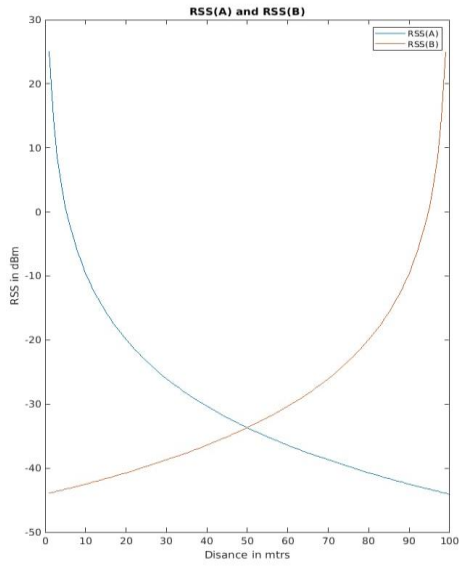

Figure 18 Variation in RSS for Node A & B for η = 1.5

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Pradeep Singh is working as an Assistant Professor in Department of Humanities & Science at Father Conceicao Rodrigues College OF Engineering, Band-stand, Bandra (West),Mumbai from June 2006. He has completed Master of Science (M.Sc.) in Mathematics from Indian Institute of Technology (IIT) – Bombay in the year 2004. He has qualified NET – CSIR with Rank -21. His main area of interest are Linear Algebra, Statistics, Partial Differential Equations, Theory of Complex Analysis.

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